



UNIVERSITI PUTRA MALAYSIA

**DISTRIBUTION AND SOURCES OF POLYCYCLIC AROMATIC
HYDROCARBONS IN SELECTED LANDFILL SITES**

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**DISTRIBUTION AND SOURCES OF POLYCYCLIC AROMATIC
HYDROCARBONS IN SELECTED LANDFILL SITES**

By

KHO HIAW GEIK

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Master**

July 2005



DEDICATION

To my dear family, my parents, my sisters and brothers, my supervisor who have been my source of inspiration, wisdom and strength through the most difficult times of my life.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

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July 2005

Chairman : Associate Professor Mohamad Pauzi Zakaria, PhD

Faculty : Environmental Studies

Polycyclic aromatic hydrocarbons are one of the most important classes of anthropogenic micro-organic pollutants that had long been of interest in the field of environmental chemistry due to the fact that a small fraction of PAHs generated and released to environment by human activities had been shown to be carcinogenic and mutagenic to mammals. Polycyclic aromatic hydrocarbons have also been reported to disrupt endocrine system in humans. Upon entering the aquatic system, PAHs partition into few different phases namely truly dissolved, colloids, suspended particulate matter, surface sediments and biota. Landfilling and disposing of waste in open dumpsite had been expected to remain the most common and significant method for disposal of municipal solid wastes in Malaysia in near future. This study focuses on 3 landfill sites in Malaysia. The objectives of this study were to understand the distribution and sources of compound-specific PAHs in the landfill leachates and to determine their transport pathway to surrounding water bodies. The distribution of PAHs between various phases was the fundamental in the control of

their movement and impact to the environment. Results from this study revealed that most of the particulate phase samples showed the higher PAHs concentration as compared to dissolved phase indicating the hydrophobicity characteristic of individual PAHs. High abundance of higher molecular weight (HMW) PAHs in particulate phase river water from Ulu Maasop Landfill had indicated the origin of the PAHs was from pyrogenic source which could be attributed to the illegal waste burning. Particulate phase leachate from Taman Beringin Landfill shows a mixture of petrogenic and pyrogenic signature although there was dominance in petrogenic signature as evidenced in their lower molecular weight/higher molecular weight ratio (LMW/HMW) of 2.21, 2.17 and 2.60. Illegal dumping of waste petroleum products could be one of the petrogenic sources entering the river. Therefore, it can be concluded that the sources of PAHs among all of the landfills in this study was a mixture of petrogenic and pyrogenic origin. Similarities in PAHs distribution profile in leachate, groundwater and river water for all landfills studied was a grave concern due to the fact that leachate may had been transported to those aquatic environment. The flow of leachates into water bodies will have to be stopped immediately in order to protect the health of our environments.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**TABURAN DAN SUMBER POLISIKLIK AROMATIK HIDROKARBONS
DARI KAWASAN TAPAK PELUPUSAN SAMPAH TERTENTU**

Oleh

KHO HIAW GEIK

Julai 2005

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Polisiklik aromatik hidrokarbons adalah sejenis bahan pencemar antropogenik dan telah menjadi tumpuan utama dalam bidang kimia alam sekitar oleh kerana walaupun terdapat sedikit bahan pencemar tersebut yang dilepaskan dari aktiviti manusia akan memberikan kesan mutasi dan karsinogenik kepada mamalia. Polisiklik aromatik hidrokarbons juga didapati boleh merosakkan sistem endokrin dalam tubuh manusia. Polisiklik aromatik hidrokarbons yang dilepaskan ke dalam sistem akuatik akan terpisah kepada beberapa fasa yang diantaranya ialah larutan mutlak, bahagian koloid, gabungan di permukaan apungan partikulat serta di permukaan sedimen dan biota. Aktiviti pembuangan pelupusan sampah di kawasan terbuka adalah satu cara yang paling umum yang terdapat di Malaysia dan dijangka akan menjadi lebih penting pada masa hadapan. Kajian ini menumpukan perhatian di tiga tapak pelupusan sampah di Malaysia. Objektif kajian ini adalah untuk memahami dengan lebih lanjut tentang taburan dan sumber PAHs dalam 'leachate' dari tapak pelupusan sampah serta cara pengalirannya ke sumber air yang terdapat di sekeliling tapak pelupusan.

Taburan PAHs dalam pelbagai fasa merupakan asas yang penting dalam kawalan pengaliran PAHs di tapak pelupusan dan kesannya terhadap alam sekitar. Keputusan kajian ini menunjukkan bahawa kebanyakan gabungan PAHs dengan bahan apungan partikulat dalam air didapati mengadungi kandungan PAHs yang lebih tinggi berbanding dengan fasa larutan mutlak PAHs dan ini dengan jelas mempamerkan hidrofobisiti PAHs tersebut secara individu. Kandungan PAHs bermolikul berat yang bergabung dengan apungan partikulat dari air sungai di tapak pelupusan Ulu Maasop menunjukkan sumber 'pyrogenic' yang mungkin disebabkan oleh pembakaran sampah secara berleluasa. Kandungan PAHs yang bergabung dengan apungan partikulat dari 'leachate' di tapak pelupusan Taman Beringin menunjukkan sumber 'petrogenic' dan 'pyrogenic' tetapi sumber petrogenik lebih dominan berdasarkan nilai nisbah LMW/HMW iaitu 2.21, 2.17 and 2.60. Pembuangan sisa petroleum secara haram menjadi salah satu daripada sumber 'petrogenic'. Kesimpulannya, PAHs yang terkandung dalam tapak pelupusan sampah adalah berpunca dari percampuran sumber 'petrogenic' dan 'pyrogenic'. Kesamaan dalam taburan profil PAHs dalam 'leachate', air bawah tanah dan air sungai di semua tapak pelupusan sampah menunjukkan kemungkinan 'leachate' akan mengalir ke sumber air yang berhampiran. Pengaliran 'leachate' ke sumber air yang berhampiran harus dielakkan dengan serta-merta untuk menjamin kesihatan alam sekeliling.

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I certify that an Examination Committee met on 1st July 2005 to conduct the final examination of Kho Hiaw Geik on her Master of Science thesis entitled “Distribution and Sources of Polycyclic Aromatic Hydrocarbons in Selected Landfill Sites” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently for any other degree at UPM or other institutions.



KHO HIAW GEIK

Date : 22 Oct 2005

TABLE OF CONTENTS

	Page
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	v
ACKNOWLEDGEMENT	vii
APPROVAL	viii
DECLARATION	x
LIST OF TABLES	xiv
LIST OF FIGURES	xvi
LIST OF PLATES	xxii
LIST OF ABBREVIATIONS AND GLOSSARY	xxiii
 CHAPTER	
 1 INTRODUCTION	
1.1 Background of Study	1
1.2 Significance of the Study	8
1.3 Objective of Study	10
 2 LITERATURE REVIEW	
2.1 Pollution Sources in Malaysia	11
2.2 Solid Waste and Landfills in Malaysia	13
2.3 What is Leachate?	16
2.3.1 Leachate Production and Generation	17
2.3.2 Leachate Composition	20
2.3.3 Environmental Impact of Leachate	22
2.4 Polycyclic Aromatic Hydrocarbons	25
2.4.1 Distribution and Sources of PAHs in the Aquatic Environment	28
2.4.2 Solubility and Bioavailability of PAHs	35
2.4.3 Degradation of PAHs in the Aquatic Environment	38
2.5 Why Focus on Polycyclic Aromatic Hydrocarbons?	40

3	MATERIAL AND METHODS	
3.1	Sampling Location	42
3.1.1	Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan	43
3.1.2	Taman Beringin Landfill, Kuala Lumpur	46
3.1.3	Sungai Kembung Landfill, Selangor	48
3.2	Analytical Method Development	50
3.2.1	Determination of Elution Volume for Silica Gel Column Chromatography	52
3.2.2	Gas Chromatography Mass Spectrometry (GC-MS) SIM (Selective Ion Monitoring) Mode	56
3.3	Analytical Procedure.	61
3.3.1	Apparatus Cleaning	61
3.3.2	Sample Collection and Preparation	62
3.3.3	Soxhlet Extraction and Liquid-liquid Extraction	63
3.3.4	Copper Activation	63
3.3.5	1 st Step Column Chromatography	65
3.3.6	2 nd Step Column Chromatography	66
3.3.7	Gas Chromatography Mass Spectrometry (GC-MS) Analysis	67
3.3.8	Calculation of Concentration in the Samples	69
4	RESULTS AND DISCUSSION	
4.1	Composition and Concentration of Polycyclic Aromatic Hydrocarbons	72
4.1.1	Dissolved Phase of Leachate and River Water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan	72
4.1.2	Particulate Phase of River Water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan	82
4.1.3	Dissolved Phase of Leachate, Groundwater and River Water from Taman Beringin Landfill, Kuala Lumpur	93
4.1.4	Particulate Phase of Leachate, Groundwater and River Water from Taman Beringin Landfill, Kuala Lumpur	105
4.1.5	Dissolved Phase of Leachate and River Water from Sungai Kembung Landfill, Selangor	115
4.1.6	Particulate Phase of Leachate and River Water from Sungai Kembung Landfill, Selangor	123

4.2	Identification of the Polycyclic Aromatic Hydrocarbons Contamination Sources within the Landfill– Use of the Source-Identifier to Determine the Sources	131
4.2.1	Dissolved Phase of Leachate and River Water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan	133
4.2.2	Particulate Phase of River Water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan	141
4.2.3	Dissolved Phase of Leachate, Groundwater and River Water from Taman Beringin Landfill, Kuala Lumpur	143
4.2.4	Particulate Phase of Leachate, Groundwater and River Water from Taman Beringin Landfill, Kuala Lumpur	152
4.2.5	Dissolved Phase of Leachate and River Water from Sungai Kembung Landfill, Selangor	155
4.2.6	Particulate Phase of Leachate and River Water from Sungai Kembung Landfill, Selangor	162
4.3	Transport Pathway of Leachate to Groundwater and River Water	165
4.3.1	Transport Pathway of Dissolved Phase Leachate to River Water at Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan	166
4.3.2	Transport Pathway of Dissolved Phase Leachate to Groundwater and River Water at Taman Beringin Landfill, Kuala Lumpur	169
4.3.3	Transport Pathway of Particulate Phase Leachate to Groundwater and River Water at Taman Beringin Landfill, Kuala Lumpur	173
4.3.4	Transport Pathway of Dissolved Phase Leachate to River Water at Sungai Kembung Landfill, Selangor	177
4.3.5	Transport Pathway of Particulate Phase Leachate to River Water at Sungai Kembung Landfill, Selangor	181
4.4	Comparison of the PAHs Concentrations in this Study with Previous Studies	185
4.4.1	Leachate and River Water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan	185
4.4.2	Leachate, Groundwater and River Water from Taman Beringin Landfill, Kuala Lumpur	187
4.5	Comparison of the Concentration of PAHs among Three Landfills in This Study	192
5	CONCLUSIONS AND RECOMMENDATIONS	195
	REFERENCES	201
	APPENDICES	211
	BIODATA OF THE AUTHOR	250

LIST OF TABLES

Table	Page
2.1 Projection of solid waste generated in Malaysia (Hassan, <i>et al.</i> , 1999).	13
3.1 Description of sampling sites at Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	44
3.2 Description of sampling sites at Taman Beringin Landfill, Kuala Lumpur.	47
3.3 Description of sampling sites at Sungai Kembung Landfill, Selangor.	50
3.4 15 PAHs target compounds and their corresponding information.	58
3.5 Selected character ions and time interval for developing SIM mode for 15 PAHs target compounds analysis.	59
4.1 PAHs concentration and source-identifier in dissolved phase ($\mu\text{g/l}$) leachate and river water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	73
4.2 PAHs concentration and source-identifier in particulate phase (ng/g) leachate and river water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	84
4.3 PAHs concentration and source-identifier in dissolved phase ($\mu\text{g/l}$) leachate, groundwater and river water from Taman Beringin Landfill, Kuala Lumpur.	94
4.4 PAHs concentration and source-identifier in particulate phase (ng/g) leachate, groundwater and river water from Taman Beringin Landfill, Kuala Lumpur.	106
4.5 PAHs concentration and source-identifier in dissolved phase ($\mu\text{g/l}$) leachate and river water from Sungai Kembung Landfill, Selangor.	116

4.6	PAHs concentration and source-identifier in particulate phase (ng/g) leachate and river water from Sungai Kembung Landfill, Selangor.	124
4.7	PAHs concentration in fresh and used 2T oil (Wong, 2004) (<i>in press</i>), used crankcase oil, asphalt and street dust (Zakaria <i>et al.</i> , 2002).	188
4.8	PAHs concentration (ng/g) in sediment from Klang river, estuary, inshore station and Straits of Malacca (Zakaria <i>et al.</i> , 2000; Zakaria <i>et al.</i> , 2001; Zakaria <i>et al.</i> , 2002).	191
B-1	Example of Sequence for Sample Injection.	217

LIST OF FIGURES

Figure	Page
1.1 Amount of wastes generated and collected in Kuala Lumpur from Year 1975 to 2015 reported by Department of Environment (DOE), 1999.	6
1.2 Illegal dumping reported by Department of Environment (DOE) from Year 1999-2003.	6
1.3 Major sources of solid wastes in Kuala Lumpur reported by Department of Environment (DOE).	7
3.1 Sampling location.	42
3.2 Sampling stations at Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	45
3.3 Sampling stations at Taman Beringin Landfill, Kuala Lumpur.	49
3.4 Sampling stations at Sungai Kembung Landfill, Selangor.	51
3.5 Molecular structure of PAHs analyzed in this study.	57
3.6 Analytical Scheme of the Polycyclic Aromatic Hydrocarbons (PAHs).	64
4.1 Composition of PAHs in dissolved phase of leachate and river water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	75
4.2 Compositional pattern of PAHs by ring size in dissolved phase of leachate and river water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	77
4.3 PAHs concentration by ring size and total PAHs concentration in leachate and river water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	78
4.4 Distribution of lower and higher molecular weight PAHs in dissolved phase of leachate and river water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	79
4.5 Comparison of concentration for each of the PAHs compounds in dissolved phase and particulate phase leachate and river water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	83

4.6	Composition of PAHs in particulate phase of river water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	86
4.7	Compositional pattern of PAHs by ring size in particulate phase of river water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	89
4.8	Distribution of lower and higher molecular weight PAHs in particulate phase of river water from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	90
4.9	A model showing a possible interaction between PAHs and soot particle within the landfill. This model is based on previous studies conducted by Karickhoff <i>et al.</i> (1979), Farrington <i>et al.</i> (1983), Farrington (1989), Gustafsson <i>et al.</i> (1997), McGroddy and Farrington (1995), Kumata <i>et al.</i> (2000) and Zakaria and Takada (2003).	91
4.10	A probable biogeochemical process occurring within the landfill. This model is based on previous studies conducted by Karickhoff <i>et al.</i> (1979), Farrington <i>et al.</i> (1983), Farrington (1989), Gustafsson <i>et al.</i> (1997), McGroddy and Farrington (1995), Kumata <i>et al.</i> (2000) and Zakaria and Takada (2003).	92
4.11	Composition of PAHs in dissolved phase of leachate, groundwater and river water from Taman Beringin Landfill, Kuala Lumpur.	95
4.12	Comparison of concentration for each of the PAHs compounds in dissolved phase and particulate phase leachate and river water from Taman Beringin Landfill, Kuala Lumpur.	96
4.13	Compositional pattern of PAHs by ring size in dissolved phase of leachate, groundwater and river water from Taman Beringin Landfill, Kuala Lumpur.	98
4.14	PAHs concentration by ring size and total PAHs concentration in leachate, groundwater and river water from Taman Beringin Landfill, Kuala Lumpur.	99
4.15	Distribution of lower and higher molecular weight PAHs in dissolved phase of leachate, groundwater and river water from Taman Beringin Landfill, Kuala Lumpur.	101
4.16	Composition of PAHs in particulate phase of leachate, groundwater and river water from Taman Beringin Landfill, Kuala Lumpur.	107

4.17	Compositional pattern of PAHs by ring size in particulate phase of leachate, groundwater and river water from Taman Beringin Landfill, Kuala Lumpur.	109
4.18	Distribution of lower and higher molecular weight PAHs in particulate phase of leachate, groundwater and river water from Taman Beringin Landfill, Kuala Lumpur.	110
4.19	Comparison of concentration for each of the PAHs compounds in dissolved phase and particulate phase groundwater from Taman Beringin Landfill, Kuala Lumpur.	111
4.20	Comparison of concentration for each of the PAHs compounds in dissolved phase and particulate phase leachate and river water from Sungai Kembung Landfill, Selangor.	117
4.21	Composition of PAHs in dissolved phase of leachate and river water from Sungai Kembung Landfill, Selangor.	118
4.22	Compositional pattern of PAHs by ring size in dissolved phase of leachate and river water from Sungai Kembung Landfill, Selangor.	120
4.23	PAHs concentration by ring size and total PAHs concentration in leachate and river water from Sungai Kembung Landfill, Selangor.	121
4.24	Distribution of lower and higher molecular weight PAHs in dissolved phase of leachate and river water from Sungai Kembung Landfill, Selangor.	122
4.25	Composition of PAHs in particulate phase of leachate and river water from Sungai Kembung Landfill, Selangor.	125
4.26	Compositional pattern of PAHs by ring size in particulate phase of leachate and river water from Sungai Kembung Landfill, Selangor.	127
4.27	Distribution of lower and higher molecular weight PAHs in particulate phase of leachate and river water from Sungai Kembung Landfill, Selangor.	128
4.28	PAHs source-identifier in dissolved phase and particulate phase of leachate (L1KP) and river water (R1KP-R5KP) from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan. (a) MP/P ratio; (b) LMW/HMW ratio; (c) Phe/Ant ratio.	134

4.29	Plots of PAHs source-identifier for source identification at Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan. (a) MP/P versus LMW/HMW-dissolved phase; (b) MP/P versus LMW/HMW-particulate phase; (c) Phe/Ant versus Fluo/Pyr-dissolved phase.	135
4.30	PAHs source-identifier in dissolved phase and particulate phase of leachate (L1KP) and river water (R1KP-R5KP) from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan. (a) Fluo/Pyr ratio; (b) BaAnt/Chry ratio; (c) Chry/BaAnt ratio.	137
4.31	Plots of PAHs source-identifier for source identification at Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan. (a) Fluo/Pyr versus BaAnt/Chry-dissolved phase; (b) Fluo/Pyr versus BaAnt/Chry-particulate phase; (c) BaAnt/Chry versus Chry/BaAnt-dissolved phase; (d) BaAnt/Chry versus Chry/BaAnt-particulate phase.	138
4.32	PAHs source-identifier in dissolved phase and particulate phase of leachate (L1TB - L3TB), groundwater (G1TB - G4TB) and river water (R1TB - R2TB) from Taman Beringin Landfill, Kuala Lumpur. (a) MP/P ratio; (b) LMW/HMW ratio; (c) Phe/Ant ratio.	144
4.33	Plots of PAHs source-identifier for source identification at Taman Beringin Landfill, Kuala Lumpur. (a) MP/P versus LMW/HMW-dissolved phase; (b) MP/P versus LMW/HMW-particulate phase; (c) Phe/Ant versus Fluo/Pyr-dissolved phase; (d) Phe/Ant versus Fluo/Pyr-particulate phase.	145
4.34	PAHs source-identifier in dissolved phase and particulate phase of leachate (L1TB - L3TB), groundwater (G1TB - G4TB) and river water (R1TB - R2TB) from Taman Beringin Landfill, Kuala Lumpur. (a) Fluo/Pyr ratio; (b) BaAnt/Chry ratio; (c) Chry/BaAnt ratio.	147
4.35	Plots of PAHs source-identifier for source identification at Taman Beringin Landfill, Kuala Lumpur. (a) Fluo/Pyr versus BaAnt/Chry-dissolved phase; (b) Fluo/Pyr versus BaAnt/Chry-particulate phase; (c) BaAnt/Chry versus Chry/BaAnt-dissolved phase; (d) BaAnt/Chry versus Chry/BaAnt-particulate phase.	148
4.36	PAHs source-identifier in dissolved phase and particulate phase of leachate (L1SK - L2SK) and river water (R1SK - R2SK) from Sungai Kembung Landfill, Selangor. (a) MP/P ratio; (b) LMW/HMW ratio; (c) Phe/Ant ratio.	157

4.37	Plots of PAHs source-identifier for source identification at Sungai Kembung Landfill, Selangor. (a) MP/P versus LMW/HMW-dissolved phase; (b) MP/P versus LMW/HMW-particulate phase; (c) Phe/Ant versus Fluo/Pyr-dissolved phase; (d) Phe/Ant versus Fluo/Pyr-particulate phase.	158
4.38	PAHs source-identifier in dissolved phase and particulate phase of leachate (L1SK - L2SK) and river water (R1SK - R2SK) from Sungai Kembung Landfill, Selangor. (a) Fluo/Pyr ratio; (b) BaAnt/Chry ratio; (c) Chry/BaAnt ratio.	159
4.39	Plots of PAHs source-identifier for source identification at Sungai Kembung Landfill, Selangor. (a) Fluo/Pyr versus BaAnt/Chry-dissolved phase; (b) Fluo/Pyr versus BaAnt/Chry-particulate phase; (c) BaAnt/Chry versus Chry/BaAnt-dissolved phase; (d) BaAnt/Chry versus Chry/BaAnt-particulate phase.	160
4.40	Relationship between dissolved phase leachate and river water in different source-identifier from Ulu Maasop Landfill, Kuala Pilah, Negeri Sembilan.	168
4.41	Relationship between dissolved phase leachate, groundwater and river water in different source-identifier from Taman Beringin Landfill, Kuala Lumpur.	171
4.42	Relationship between particulate phase leachate, groundwater and river water in different source-identifier from Taman Beringin Landfill, Kuala Lumpur.	175
4.43	Composition of PAHs in sediment from Klang river, estuary, inshore station and Straits of Malacca (Zakaria <i>et al.</i> , 2000; Zakaria <i>et al.</i> , 2001; Zakaria <i>et al.</i> , 2002).	178
4.44	Relationship between dissolved phase leachate and river water in different source-identifier from Sungai Kembung Landfill, Selangor.	180
4.45	Relationship between particulate phase leachate and river water in different source-identifier from Sungai Kembung Landfill, Selangor.	182
4.46	Composition of PAHs in fresh and used 2T oil (Wong, 2004) (<i>unpublished</i>), used crankcase oil, asphalt and street dust (Zakaria <i>et al.</i> , 2002).	186

B-1	Typical GC-MS chromatogram of a PAHs standard mixture.	213
B-2	Example of GC-MS chromatogram in leachate sample.	214
B-3	Example of GC-MS chromatogram in groundwater sample.	215
B-4	Example of GC-MS chromatogram in river water sample.	216

LIST OF PLATES

Plate		Page
A-1	The view of landfill.	212
A-2	Landfill leachate.	212
A-3	Illegal burning of waste.	212
A-4	Landfill internal burning.	212
A-5	Groundwater sampling.	212
A-6	River water sampling.	212

LIST OF ABBREVIATIONS AND GLOSSARY

PAHs	Polycyclic aromatic hydrocarbons
GC-MS	Gas chromatography mass spectrometry
IISTD	Internal injection standard
SIS	Surrogate internal standard
SIM	Selective ion monitoring
DBT	Dibenzothiophene
Phe	Phenanthrene
Ant	Anthracene
3MPhe	3-methylphenanthrene
2MPhe	2-methylphenanthrene
2MAnt	2-methylanthracene
9MPhe	9-methylphenanthrene
1MPhe	1-methylphenanthrene
Fluo	Fluoranthene
Pyr	Pyrene
1MPyr	1-methylpyrene
BaAnt	Benz(a)anthracene
Chry	Chrysene
BkFluo	Benzo(k)fluoranthene
BeAcep	Benz(e)acephenanthrylene
BePyr	Benzo(e)pyrene
BaPyr	Benzo(a)pyrene
DBahAnt	Dibenz(a,h)anthracene
LMW	Lower molecular weight
HMW	Higher molecular weight



MP/P ratio	A ratio of the sum of 3-methylphenanthrene, 2-methylphenanthrene, 9-methylphenanthrene, 1-methylphenanthrene to phenanthrene
LMW/HMW ratio	A ratio of the sum of dibenzothiophene + phenanthrene + anthracene + 3-methylphenanthrene + 2-methylphenanthrene + 2-methylanthracene + 9-methylphenanthrene + 1-methylphenanthrene + fluoranthene + pyrene relative to sum of 1-methylpyrene + benzo(a)anthracene + chrysene + benzo(k)fluoranthene + benz(a)acephenanthrylene + benzo(e)pyrene + benzo(a)pyrene + dibenz(a,h)anthracene
Phe/Ant ratio	A ratio of phenanthrene relative to anthracene
Fluo/Pyr ratio	A ratio of fluoranthene relative to pyrene
BaAnt/Chry ratio	A ratio of benz(a)anthracene relative to chrysene
Chry/BaAnt ratio	A ratio of chrysene relative to benz(a)anthracene
Pyrogenic	High temperature anthropogenic combustion process such as combustion of oil, coal, wood, natural fire, etc.
Pyrolytic	Same as pyrogenic
Petrogenic	Low temperature maturation of hydrocarbon product or anthropogenic petroleum inputs from municipal discharge, tanker accident, storm water runoff, etc.
Source-identifier	MP/P ratio, LMW/HMW ratio, Phe/Ant ratio, Fluo/Pyr ratio, BaAnt/Chry ratio and Chry/BaAnt ratio.

